Treatment Technologies

Incineration

"Incineration of medical wastes remains a prevalent treatment method in the United States. The advantages of incinerating medical wastes, are those associated with the incineration of any type of waste: significant volume reduction (by about 90 percent), assured destruction, sterilization, weight reduction, and the ability to manage most types of wastes with little processing before treatment. The disadvantages include potential pollution risks associated with incineration processes and increased costs associated with controlling pollution emissions" (U.S. Congress Office of Technology Assessment, 1990, p. 41).

Maine Biomedical Waste Management Rules specify the following general design standards for medical waste incinerators:

1. The types, amounts (by weight and/or volume), and characteristics of all medical waste expected to be processed shall be determined by survey.
2. Facility design capacity shall consider such items as waste quantity and characteristics, variations in waste generation, equipment downtime, and availability of alternate storage, processing, or disposal capability.
3. Facility systems and subsystems shall be designed to assure standby capability in the event of breakdown.
4. Audible signals shall be provided to alert operating personnel of critical operating unit malfunctions.

Additional recommendations for all types of incinerator systems from the states of *Maine* and *Washington* include the following.

5. Grated beds should not be used for the incineration of liquid wastes.
6. Incinerator design should include measures to minimize infiltration air. This would reduce the consumption of auxiliary fuel, increase residence time, and increase exposure of combustion gases to high temperatures.
7. Stack design and location should be of sufficient height and located to assure that stack emissions do not enter nearby building ventilation systems or windows. Stacks should be designed according to EPA- defined "good engineering practices."

For new or modified sources, stack design should comply with the intentions of the proposed state air toxics regulations upon promulgation.

2. A detailed narrative explaining how the facility will operate, including, but not limited to, design capacity, equipment specifications, on site storage, and flow diagram schematics for all parts of the facility;
3. Total capacity and life expectancy of the facility, including calculations used to derive these data;
4. Hours and days of operation at the facility and the number of conveyances delivering biomedical wastes that are expected daily and that can be accommodated daily;
5. A general inspection schedule for the facility;
6. A description of security procedures and equipment;
7. Training procedures for personnel who handle biomedical waste;
8. Emergency spill containment and cleanup procedures and equipment;
9. The name, address, and telephone number of the person(s) responsible for biomedical waste management for the facility.

Operation (General)

Operational requirements for treatment facilities include restricted access, waste identification, safe handling to avoid puncturing containers, and adhering to charging rates that are within incinerator or autoclave design.

Operating standards include methods and operational requirements for waste treatment, design requirements, quality control guidelines, reporting requirements, and procedures for preventing and cleaning up medical waste spills.

Monitoring and Record Keeping (General)

Monitoring is essential in development of standard operating procedures for each treatment technique to verify that the treatment process is effective. Monitoring also permits refinement of the operating procedures so that excess processing can be avoided while savings are realized in expenditures of time, energy, and/or materials. Subsequent periodic monitoring serves to demonstrate that treatment is adequate to render the waste non-infectious, thereby confirming that proper procedures were used and that the equipment was functioning properly.

Medical waste disposal facilities should maintain records of:

1. Policies and procedures for handling medical waste;
2. Special training received by persons involved with medical waste management;
3. Spills of medical waste and containment methods employed;
4. Members of the facility's infection control committee;
5. Operating information (e.g., hours of operation, equipment maintenance and replacement, inspections);
6. Monitoring results;
7. Medical waste received from off-site:
   a. waste type and volume;
   b. generator name and address;
   c. transporter;
   d. treatment and disposal method.

Treatment Technologies

Incineration

Incineration converts combustible materials into noncombustible residue or ash, exhaust gases, and heat. Incineration of medical waste should be conducted under sufficient burning conditions (e.g., temperature, residence time, and feed quantity) to reduce all combustible material to a form such that no portion of the combustible material is visible in its uncombusted state and to control emissions of hazardous constituents during incineration.

An on-site incineration facility should include the following factors.

- There should be access to equipment for service and replacement.
- Shelter for equipment is needed to protect it from the elements.
- Incineration equipment and support elements, such as scrubbers or bag houses, bulk storage chemicals, and flue stacks are fairly massive and should be placed at a grade.
- Traffic flow for trucks and cars should not interfere with the movement of waste containers.
- Due to the uneven waste stream collection and flow to the incinerator, a staging area of sufficient capacity is needed to hold waste during heavy

8. Automated, continuously operated feed systems are desirable because they minimize fluctuations in temperature and maintain a steady rate of operation, thus tending to emit lower levels of pollutants.

Incinerator Operation: "The successful use of incineration as a method for treating infectious waste ultimately depends on the proper operation of the incinerator and air-pollution control devices. Good operating technique affects the reliability of equipment, reduces down-time, prolongs the life of equipment, increases combustion efficiency, helps ensure complete ash burnout, increases worker safety, and assists compliance with air pollution control regulations" (Turnberg, 1989, Attachment 7, p. 52).

The following aspects of incinerator operation and maintenance contribute to complete destruction of medical wastes.

1. *Waste Feed Rate and Characterization:* Avoid overloading and adjust for waste composition.

a. The following variations in waste composition affect operation:

- moisture content and heating value affects combustion temperature;
- high plastic content can cause temperature surges that can damage the incinerator;
- combustion products of waste with chlorine content is corrosive to the incinerator and may damage the refractory (chamber lining) and the stack.

b. Controlled-air type: capacity of the secondary chamber determines the waste charging or feed capacity of the incinerator.

c. Waste should not be loaded into the incinerator until it has been preheated and pollution control devices are fully operational.

d. Wastes containing solvents should be avoided.

e. Overloading of waste, or the burning of high heating value wastes in an incinerator designed to burn at lower temperatures can lead to overheating of thermocouples and crack the refractory.

2. *Temperature and Residence Time:* Medical waste incinerators should be capable of maintaining a minimum temperature in the primary chamber sufficient to destroy infectious agents and produce a residue essentially free of odors and unstable organic matter. collection periods. This waste should be incinerated later the same day

- Due to extensive heat radiation from equipment, most incineration enclosures are not insulated but are very well ventilated.

Training for Incinerators: A trained incinerator operator should be present at the facility in which an incinerator is located whenever waste is being burned. The facility-employed operator will control the operation of the incinerator performance testing.

An incinerator operator should be trained to deal with the complexity of medical waste composition and potential hazards, incinerator equipment, air pollution control devices, monitoring information, and applicable regulations.

The American Society of Mechanical Engineers is establishing a U.S. EPA-sponsored certification and training program for operators of medical waste incineration equipment. The proposed program will include the following:

- basic principles of combustion
- incinerator equipment characteristics
- medical waste characteristics
- products of waste combustion
- air pollutants
- air pollution control devices
- automatic control systems
- emission monitoring equipment
- industrial hygiene
- typical problems
- scheduled maintenance
- incinerator operations
- state and other applicable regulations.

In addition, an incinerator operator training program should provide an understanding of the following elements:

- proper waste handling procedures
- environmental and health concerns related to improper incineration
- worker safety procedures
- record keeping procedures
- accident response.

Incinerator Operation: The handling of the ash produced by incineration warrants special precautions.

1. Incinerator ash residue:

a. Removal should occur in such a way that there will be no fugitive emissions to the air during loading or transport. The ash should be wetted prior to handling to prevent dust emissions.

b. All personnel handling ash should wear or use dust masks, gloves, and protective clothing as a safety precaution.

2. Bottom ash:

a. handle in a manner consistent with asbestos management standards (40 CFR Part 61) and dispose of in a solid waste disposal facility.

3. Fly ash:

a. would need to be handled as a toxic waste or extremely hazardous waste based on sampling results.

Incinerator Monitoring: Monitoring of incinerator performance and residues will help to detect equipment malfunction and ensure the complete destruction of medical wastes.

Monitoring should include the following elements:

1. Monitors should provide continuous information on combustion temperature and waste, fuel, and air feed rates.

2. Continuous recording parameters include temperature, key operating parameters of air pollution control equipment, waste charging rates, and carbon monoxide and particulate emission monitors.

3. Stacks should be equipped with continuous emission monitors which measure opacity.

4. Ash: Visual inspection should not reveal commonly combustible materials such as paper, cardboard, and cloth which have not been completely burned.

5. Annual inspection.

6. Records should be kept of the weight and general composition of waste charged to the incinerator.

Steam Sterilization

Steam sterilization is a treatment method for medical waste that utilizes saturated steam within a pressure vessel (known as a steam sterilizer, autoclave, or retort) at time lengths and temperatures sufficient to kill infectious agents within the waste.

a. Operating temperatures should be attained before loading the waste.

b. The amount of air and fuel should be adjusted to maintain operating temperature at the necessary level.

c. Adjustments should be made as the composition of the waste changes.

Incinerator Maintenance: "Scheduled preventive maintenance, regular cleaning, and visual inspection of equipment is recommended to avoid excessive emissions and costly breakdowns" (Turnberg, 1989, Attachment 7, p. 45). Worn refractories should be replaced, ash deposits on walls and ducting should be removed, air inlets should be cleaned and replaced, and worn mechanical parts should be replaced. (See table below)

Incinerator Monitoring: Wisconsin guidelines recommend that incinerator operators continually record combustion temperatures and amounts of waste incinerated. In Pennsylvania incinerators must report quarterly on the microbiological analysis of ash,

Operation for Steam Sterilization: Standard, written, operating procedures should be adopted for each steam sterilizer including time, temperature, pressure, type of waste, type of container(s), closure on container(s), pattern of loading, waste content, and maximum load quantity.

Operation should include the following procedures:

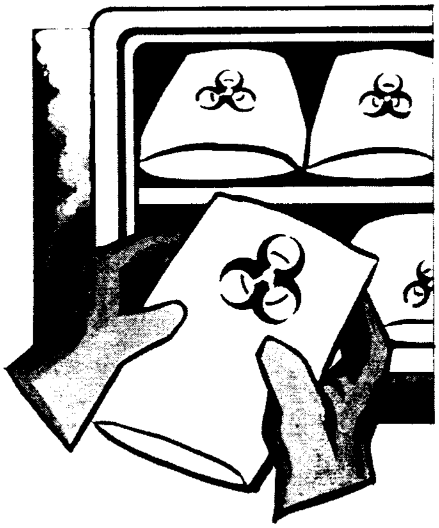
1. The entire waste load should be exposed to the necessary temperature for a defined period of time.

Typical Maintenance Inspection
Lubrication and Cleaning Schedule for a Biomedical Waste Incinerator

Frequency	*Incinerator Component*	*Procedure*
Hourly	Ash removal conveyor	Inspect & clean as required
	Water quench pit	Inspect water level and fill as required
Daily	Opacity monitor	Check operation of the opacity monitor & check exhaust for visible emissions
	Oxygen monitor	Check operation of oxygen monitor
	Thermacouples	Check operation of thermocouples
	Underfire air ports	Inspect & clean as required
	Limit switches	Inspect for freedom of operation & potential obstructing debris
	Door seals	Inspect for wear, closeness of fit & air leakage
	Ash pit/internal dropout sump	Clean after each shift on batch units w/o continuous ash conveyor system
Weekly	Heat recovery boiler tubes	Inspect & clean as required. Clean weekly for 6 weeks to determine optimum cleaning schedule
	Blower intakes	Inspect for accumulation of lint, debris; Clean as required
	Burner flame rods (gas-fired units	Inspect & clean as required
	UV scanner flame sensors	Inspect & clean as required
	Swing latches and hinges	Lubricate
	Hopper door support pins	Lubricate
	Ram feeder carriage wheels	Lubricate
	Heat-recovery induced-draft	Inspect & clean fan housing as required. Check for corrosion. Check V-belt drives and chains for wear
	Hydraulic systems	Check hydraulic fluid level & add the proper replacement fluid as required. Investigate sources of fuel leakage
Biweekly	Ash removal conveyor bearings	Lubricate
	Fuel trains & burners	Inspect & clean as required. Investigate sources of fuel leakage
	Control panels	Inspect & clean as required. Keep panel securely closed & free of dirt to prevent electrical malfunction
	External surface of incinerator & stack	Inspect external "hot" surfaces. White spots or discoloration may indicate loss of refractory
Monthly	Refactory	Inspect & repair minor wear areas with plastic refractory material
	Internal ram faces	Inspect for wear. These stainless steel faces may wear out and may require replacement in 1 to 5 years depending on service
	Upper/secondary combustion chamber	Inspect & vacuum any particulate matter that has accumulated on the chamber floor. Lubricate
	Large combustion air blowers & heat recovery induced draft fans (fans whose bearings are not sealed)	Lubricate
	Hydraulic cylinder clevis & trunnion attachments to all moving components	Inspect & adjust as required
	Burner pilots	Inspect & paint with high temperature as required
	Hot external surfaces	Inspect & paint with equipment as required
Semi-annually	Ambient external surfaces	Inspect & brush clean as reuired. Lubricate chamber
	Chains	Lubricate

Source: U.S. EPA. *Operation and Maintenance of Hospital Medical Waste Incinerators.* EPA 450/3-89-002, Work Assignment 16, March 1989 in Turnberg, 1989, Attachment 7, pp. 46-48.

and annually on ash's chemical analysis. Monitoring data shall be maintained for a period of three years.



Chemical Disinfection

"Chemical agents such as chlorine have been used as disinfectants for medical products for some time, although the applications to large volumes of infectious wastes generated in hospitals and laboratories is more recent" (U.S. Congress, Office of Technology Assessment, 1990, p. 33). Currently there aren't any disinfectants registered with the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) for use with medical waste. FIFRA registers by use. Most are surface disinfectants.

For infection control purposes, disinfectants are chemical germicides that are approved for use as hospital disinfectants and are tuberculocidal when used at recommended dilutions. (See table on following page.)

2. The degree of steam penetration is the critical factor. Air must be completely displaced from the treatment chamber for steam penetration to occur.

3. Residual air in the autoclave chamber prevents effective sterilization. It may be due to use of impervious plastic bags, use of deep upright containers, or improper loading.

4. Loads should be small enough to attain and maintain sterilizing temperatures.

5. Bags should be opened and bottle caps and stoppers should be loosened immediately before placement in the sterilizer to facilitate steam penetration. Adding water to containers is recommended to assure steam contact with waste.

Maintenance: Maintenance should include the following.

1. Sterilizers should be routinely inspected and serviced.
2. Monitoring will indicate that the equipment is functioning properly.

Monitoring and Record Keeping for Steam Sterilization: Routine performance checks and record keeping will ensure that autoclaves will be maintained in optimal working condition and that wastes are being thoroughly sterilized.

Monitoring should include the following:

1. A recording thermometer should be used to ensure that a sufficiently high temperature is maintained for an adequate period of time during the cycle.
2. A chemical indicator strip/tape that changes color when a certain temperature is reached can be used to verify that a specific temperature has been achieved. It may be necessary to use more than one strip over the waste package at different locations to ensure that inner content of the package has been adequately autoclaved. However, it does not show the length of time waste has been exposed to steam at that temperature.
3. Bacillus stearothermophilus is recommended as the biological indicator. Steam sterilization units should be evaluated under full loading for effectiveness with spores of Bacillus stearothermophilus placed at the center of a load processed under standard operating conditions no less than once per every 40 hours of operation. Because of the risk of unnecessary exposure to the worker who must retrieve the monitor, testing should be done in a simulated waste load and not with an actual load of medical waste.
4. A log should be kept at each steam sterilization unit that is complete for the preceding three year period. The log shall record the date, time, and operator of each usage; the type and approximate amount of waste treated; the post-sterilization reading of the temperature sensitive tape; the dates and results of calibration; and the results of effective testing.

Training for Steam Sterilization: Operator training should include the following components:

1. Knowledge of standard autoclave principles and recognition of proper operation;
2. Knowledge of waste stream characteristics;
3. Minimization of aerosols;
4. Prevention of waste spillage;
5. Wearing protective attire to prevent burns;
6. Quality assurance testing and frequency of testing.

Chemical Disinfection with Grinding or Incapsulation

This treatment process grinds the wastes in a hammermill in the presence of a chemical disinfectant. Factors that should be considered in selection of chemical disinfection as a treatment method are the types of microorganisms likely to be present in the waste, the degree of contamination, the amount of proteinaceous material present, and the type of disinfectant.

Operation for Chemical Disinfection: Several factors influence the effectiveness of chemical disinfection. The type of disinfectant used, its quantity and concentration, contact time with the waste, and the temperature at which it and the wastes are treated determine the completeness of the disinfection process.

Thermal Inactivation

The batch units "consist of a vessel of sufficient size to contain the liquid generated during a specific operating period (e.g., 24 hours). The system may include a second vessel that provides continuous collection of waste without interruption of activities that generate the waste.

"The waste may be pre-heated by heat exchangers, or heat may be applied by a steam jacket that envelopes the vessel. Heating is continued until a pre-determined temperature (usually measured by a thermocouple) is achieved and maintained for a designated period of time." The contents of the vessel/tank are normally discharged to the sewer. Local, state or federal temperature restrictions on sewer discharges may necessitate a second heat exchanger to remove excess heat from the effluent (U.S. Environmental Protection Agency, 1986, p. 4.11-12).

The Minnesota Pollution Control Agency has approved electro-thermal-

The liquids resulting from chemical disinfection, including any remaining disinfecting agents, are released to the sewer system. If the chemical disinfectant is recyclable with some processing of used/spent disinfectant liquid then the effort should be made. Solid residues are drained of the disinfectant and disposed of in a landfill.

The following disinfectants are recommended for use in chemical disinfection:

- Chlorine compound solutions, specifically hypochlorite and chlorinated isocyanurates, at a strength of fifteen percent (volume/volume);
- Chemicals registered with the U.S. Environmental Protection Agency as virucidal, bactericidal, fungicidal, parasiticidal, and sporicidal;
- Chlorine bleach should not be used in the presence of Iodine-125 due to potential release of radioiodine. Formalin or a phenolic disinfectant should be substituted.

Thermal Inactivation

Thermal inactivation is a treatment method that utilizes heat transfer to provide conditions that reduce the presence of infectious agents in waste. Thermal inactivation units for the treatment of liquid wastes are batch-type units or continuous treatment processes. The batch-type unit is a vessel in which the waste may be pre-heated by heat exchangers or by a steam jacket that envelopes the vessel. The continuous process consists of a small feed tank and a steam-based heat exchanger. Liquid waste is fed into the feed tank, across the heat exchanger and then recirculated through the tank. Thermal inactivation of solid waste is accomplished by the application of dry heat in an oven which is usually operated by electricity.

Operation for Thermal Inactivation: Thermal inactivation operations should include the following.

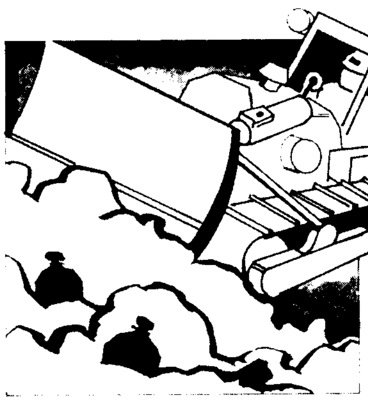
Comparison of Selected Chemical Disinfectants

	Chlorine Compounds	*Iodophor*	*Alcohols (a)*	*Formaldehyde*	*Glutaraldehyde*
Inactivates					
Vegetative bacteria	yes	yes	yes	yes	yes
Lipoviruses	yes	yes	yes	yes	yes
Nonlipid viruses	yes	yes	(b)	yes	yes
Bacterial spores	yes	yes	no	yes	yes
Treatment requirements					
Use dilution	500 ppmc (c)	25-1600 ppmc	70-85%	0.2-8.0%	2%
Contact time, min.					
Lipovirus	10	10	10	10	10
Broad spectrum	30	30	not effective	30	30
Important characteristics					
Effective shelf life is greater than 1 week	no	yes	yes	yes	yes
Corrosive	yes	yes	no	no	no
Flammable	no	no	yes	no	no
Explosion potential	none	none	none	none	none
Inactivated by inorganic matter	yes	yes	no	no	no
Skin irritant	yes	yes	no	yes	yes
Eye irritant	yes	yes	yes	yes	yes
Respiratorirritant	yes	no	no	no	no
Toxic	yes	yes	yes	yes	yes
Applicability					
Waste liquids	yes	no	no	no	no
Equipment surface decontamination	yes	yes	yes	yes	yes

(a) Ethyl and isopropyl alcohols.
(b) Results are variable, depending on the virus.
(c) Concentration of available halogen.

Source: Reinhardt and Gordon, 1991, p. 117

deactivation technology for the decontamination of medical waste: "This process involves pre-shredding the waste, initially heating it with an electric source, and then maintaining a temperature of 194 degrees F within the waste for at least two hours while in a large, enclosed chamber (Minnesota Pollution Control Agency, p. 2). This process is currently being used in Alaska.



1. Mixing may be appropriate to maximize homogeneity of the waste and temperature during the loading and heat application steps of the treatment cycle.

2. Temperature and Residence Time:

a. Requirements can be selected on the basis of the resistance of either the pathogen present in the waste or of a pathogen that is more resistant than those being treated.

b. Shorter contact time in a continuous treatment process may require a higher temperature than in a batch-type system.

c. Circulation of the air is necessary to ensure that all waste reaches the required temperature.

Monitoring for Thermal Inactivation: The only continuous monitoring currently available is temperature. Pathogen destruction monitoring involves periodically spiking the waste with a known quantity of heat-resistant bacteria and testing viability after treatment. However, retrieval of the monitor may result in unnecessary worker exposure. Therefore, testing should be done in a simulated waste load.

Irradiation

Irradiation exposes wastes to ultraviolet or ionizing radiation from a source such as cobalt 60 in an enclosed, shielded chamber. Irradiation is suitable for use on materials which cannot be thermally treated. The advantages of this treatment method are its small electricity needs, no steam requirement, and the lack of residual heat in treated waste. Disadvantages are the large capital outlay, the necessity of highly skilled personnel, the disposal of the decayed radiation source, and the need for a large operating space. Another disadvantage in ultraviolet radiation is that the method is only effective if the ultraviolet radiation reaches the waste material. There is very little penetration into the waste unless the waste is transparent to ultraviolet radiation. Areas shadowed from the ultraviolet radiation will not be effectively treated.

Operation for Irradiation: Irradiation operation procedures should include the following:

1. Microorganisms must have direct exposure to the UV rays for a sufficient length of time.

2. Relative humidity can affect treatment effectiveness of ultraviolet radiation.

3. Minimum exposure rate has not yet been determined.

Grinding and Shredding (Destruction Method)

This method is used to convert treated and some untreated medical wastes into a more homogeneous form that can be easily handled. The wastes are physically broken into smaller particles. Grinding and shredding makes waste unrecognizable, facilitates treatment (e.g., autoclaving, disinfection), and minimizes storage, transport and handling costs.

Operation for Grinding and Shredding: The equipment should maintain a negative pressure to ensure that no materials escape from the device. HEPA (high efficiency particulate air) filtration of exhaust is recommended to minimize aerosolization.

The quantity of metal and glass present, the size of the waste, and the presence of fibrous, rubber, or soft plastic materials adversely affect the process. Metal and glass can wear down the grinding edges of the equipment. Fibrous, rubber or soft plastic materials may become caught on the hammermills and cause the equipment to malfunction.

Monitoring for Grinding and Shredding: Observation of the shredded waste's size distribution verifies that the equipment is functioning properly.

Compaction (Destruction Method)

Compaction is used in the waste handling process to reduce waste volume. It can also affect recognizability. It does not decrease the disease transmission capability of medical waste.

A hydraulic ram is generally used to compress the waste against a rigid surface. The disadvantages of this method are the potential for aerosolization, the high probability of leakage, and poor incineration characteristics. Compaction can destroy

Alternative Treatment Technologies

Chemical decontamination:

"Recently, a chemical decontamination system with the potential for more widespread application has been developed. The system processes infectious waste using an electrocatalytic system. The system purportedly will destroy any known living organism by the oxidizing solution's temperature, acidity, and chemical activity. The system requires no pressure vessels and only normal amounts of electric power" (U.S. Department of Health and Human Services, 1990, p. 7.3).

Microwave:

Unlike thermal treatment which heats wastes externally, microwave heating occurs inside the waste material. The Minnesota Pollution Control Agency has given microwave technology approval for decontamination of medical waste: "This process involves preshredding the waste, injecting it with steam, and heating it for 25 minutes at 203 degrees F under a series of microwave units. The material is rotated on an auger to ensure that uniform heating and decontamination occur. The treated waste may then be landfilled or incinerated" (Minnesota Pollution Control Ageny, p. 2). Minnesota reports that the process is currently being used in California, North Carolina and some European countries.

The following types of wastes are suitable for treatment by microwaving: refuse containing blood, secretions, bandages, napkins, single-use hypodermic needles and cannulas. This method is not suitable for body parts, organ refuse, or other waste that requires special treatment such as animal cadavers, outdated medications, chemicals and radioactive waste (Stewart et. al., 1989, p. III.17).

Macrowave:

One new treatment method is the use of macrowaving. Macrowaves are low frequency radio waves which treat waste by electro- thermal deactivation. Heat produced by the waves kills disease-causing pathogens throughout the waste. The advantages of this treatment technique are that it generates no air or water discharge and the materials treated are recyclable. A macrowaving facility currently in operation does not accept pathological, chemical or hazardous waste ("Stericycle Substitutes Radio Waves for Irradiation in Treatment Process" in National Solid Wastes Management Association, January 7, 1991, p. 3).

Approval:

New York state specifies the following for the approval of alternative regulated medical waste treatment systems:

"a. Any method or technique for treatment or disposal of regulated medical waste for which approval by the Commissioner is sought must not pose a threat to public health. Approval shall be based on detailed information, obtained in conformance with generally recognized scientific principles, submitted by the applicant for a method or technique which will render the waste non-infectious, safer for transport, amenable for storage, or reduced in volume.

b. The method or technique shall conform to principles generally recognized within the scientific community and will:

i. decontaminate the waste, or change the character of the waste so as to make it safer or more amenable for transport, or reduced in volume; and

ii. not create a threat to health or safety; and

iii. not violate applicable environmental laws or regulations" (Title 10 Health: Chapter II - Part 70 Regulated Medical Waste, Subpart 70-2).

Landfill

"A landfill does not provide an environment that is conducive to the survival of human pathogens" (Minnesota, 1988, p. IV.7). High temperature (100-120 degrees F. or greater), oxygen depletion, pH, moisture, and microbial conditions reduce the number of viable infectious organisms.

It is also unlikely that pathogens will reach the groundwater beneath a properly sited landfill. "As a leachate percolates through the soil, its pathogenic organism concentration in the leachate is reduced by 'soil filtration,' a process somewhat analogous to the attenuation of sewage in a septic system. "The infectious organisms cling to the edges of soil particles and, without the nutrients, quantity of oxygen the integrity of containers, resulting in possible exposure of waste handlers to the waste materials.

The 1986 EPA Guidelines discourage the use of compaction in the handling of medical waste. The 1989 Medical Waste Tracking Act does not recognize compaction as an acceptable destruction technique. This method is therefore not recommended for untreated wastes.

Alternative Treatment Technologies

The following information should be requested from a manufacturer of an alternative medical waste treatment method to determine whether the treatment method is suitable for use by a generator or treatment facility operator:

- name of firm
- address
- contact person
- phone number
- indication as to whether the method is intended for treatment of microbiologics, sharps or both
- a brief description of the method
- statement as to how this method deactivates, kills, disinfects or sterilizes microbiologically contaminated waste, and attachment of microbiology laboratory results indicating level of treatment (e.g., disinfection or sterilization)
- how this method renders sharps unrecognizable, unusable, and incapable of causing puncture injury
- chemical substances or radiologic methods used
- important operational parameters
- if the method results in the production or release of hazardous substances.

Landfill

Medical waste that has been treated as described in previous sections and packaged such that it is clearly evident that the waste has been effectively treated is no longer subject to management as medical waste and may be collected, transported and disposed of as municipal solid waste. Therefore, once medical waste has been treated, it may be disposed at a sanitary landfill as regular municipal waste.

and other conditions necessary to their survival, eventually die off" (Ibid., pp. IV.8-9). "...bacteria in the aerated zone above the water table rarely move downward through homogeneous soil more than five feet. If bacteria do enter the saturated zone, they will travel in a fairly narrow band a few feet wide and normally will completely disappear after travel of about 100 feet downstream from the point of entry in unconsolidated formation. Therefore, if solid wastes are deposited in a properly constructed sanitary landfill, there should be little chance of contamination of groundwater with pathogenic micro-organisms" (DeRoos, R. 1972. Environmental Considerations in the Ultimate Disposal Choice for Hospital Waste (unpublished) in Minnesota, 1988, IV-9.).

Documentation

Sewer

"Certain types of infectious waste water are routinely sterilized by heat before they are discharged into the sanitary sewer system or into a receiving stream such as a river. Examples of these wastes include some wastewaters from research and industrial laboratories and from pharmaceutical production. For these wastewaters, the treatment of choice is often thermal inactivation/sterilization" (Reinhardt and Gordon, 1991, p. 111).

State and local wastewater quality regulations usually impose limits on a variety of constituents and parameters including chemicals, pH, organic material (biochemical oxygen demand or BOD), and total suspended solids (Reinhardt and Gordon, p. 121).

Guidelines

Sewer

Liquid medical waste can be disposed of into a health department approved on-site septic system or a sanitary sewer system for treatment at the wastewater treatment plant if the system is not a combined sanitary/storm sewer system. Untreated medical wastes should not be placed into a combined sanitary/storm sewer system. Medical waste disposed of to the sanitary sewer system must meet state and local regulations on wastewater quality.

The grinding and sewering of medical waste solids causes two concerns: the potential for the generation of an infectious aerosol and the clogging of sewer lines with a rope-like material that can form as a result of increased organic matter loading into the system. Sewers are suitable for the disposal of liquid wastes only.

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